Self-healing Adaptive Network Technologies for IVHM

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NEONet Workshop
April 9, 2008

Terminology and Concepts

- Context: commercial aircraft and aviation
- Integrated Vehicle Health Management (IVHM)
  - Communication system and components used to generate, transmit, and combine information to form parameters on the health of various systems
- What is “health” of a system?
  - The ability for each device, function, or system to perform within expectations.

Terminology and Concepts (cont.)

- Self-healing Adaptive Network Technologies
  - Tolerate faults within the architecture
  - Quickly detect problems and correct communication disruptions
  - Make adjustments in an automated fashion
  - Allow for different types of physical communication
- Current IVHM systems rely only on wired communication

Goals

- Enable the use of wireless communications
  - Sensors in remote areas or harsh environments (ie: Engines)
  - Decrease cost and mass associated with wires
- Easier to scale and extend IVHM network
  - Increase the quantity of sensors
  - Increase robustness in communication paths

Goals (cont.)

- Help reduce maintenance and repair expenses
  - Monitoring of areas that could only be done by manual inspection previously
  - Ability to add sensors more easily
    - Add to trouble areas that are discovered after using the aircraft for some time
    - Can avoid the need to route wires

Requirements

- Size and Power
  - Some area have severe space constraints
  - Some sensors may need to rely on battery power
- Scale
  - Large number of sensors in a subsystem
  - Need to operate efficiently
- Timeliness
  - Sensitivity of periodic measurements should not suffer when compared to current methods

Yet Another Sensor Net?

- Well hold on... Some differences
  - Most sensor-net architectures deal with nodes that move, drop, or arrive at some non-negligible rate
  - Sensors on an aircraft will be relatively fixed in location
    - May move modestly if on a movable part (ie: landing gear)
    - Additions would happen in a controlled environment
    - Drops would be due mostly to faults
- So we need to “route around” the potential faults when they happen...

Yet Another Terrestrial Net?

- So this sensor-net would be better treated as a typical terrestrial network?
  - Use OSPF or IS-IS for routing?
- Hang on though...
  - Sensor-nets are constrained; Wireless communications
  - Significant overhead and “chattiness” of typical routing protocols wouldn't work well here

Couple of Experimental Concepts

- Great, more crazy ideas?
  - Maybe...
- Assumptions
  - IPv6
  - Data to send is relatively small in size
  - Data is intended to be transmitted periodically
  - Sending a slightly longer message is better than sending multiple messages
    - Wireless power savings, don't need to sync up as often

No. 1) Piggybacking Routing Data

- Use an IPv6 extension header to piggyback routing data instead of sending it separately
  - ie: Hop-by-Hop extension header that sends IS-IS routing data
- If you don't have data to piggyback on, send out an independent packet.
  - ie: Need to send a keep-alive, and you have not seen any data recently.
  - Cold start

Benefits and Potential Issues

- Reduces the number of messages that need to be sent
  - Leverage periodic data transmissions
  - Reduces power needs (re-sync costs)
  - Reduces overhead: Only need a small bit of overhead to identify the extension header
- Probably could not directly port existing routing protocol behavior... may need adjusting for this type of logic

No. 2) IPv6/8

- IPv6 has a rather large header which mainly consists of large addresses
- IPv6 offers more advantages than just larger address space
- In a “small” closed network, do we really need to send the whole address range?
  - Trim an IPv6 prefix (aka don't send it) to obtain smaller addresses (ie: 1/8 current size)
- Can still maintain global routability

No. 2) IPv6/8 (cont)

- Global addressability? How?
  - One boarder router to an IPv6 could re-append the applicable prefix
  - One way of making the sensor-net “mobile” without touching the internal nodes
  - Similar a bit in concept to 4/6 solutions
- Provides a relatively fixed gain
- Could be handled by other means (ie: compression)

Thoughts or comments??

Thank You